Treatment of Massive Obesity With Rice/Reduction Diet Program

An Analysis of 106 Patients With at Least a 45-kg Weight Loss

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• **One hundred six massively obese patients, who each lost at least 45 kg, were treated as outpatients with the rice/reduction diet, exercise, and motivational enhancement under daily supervision. Average weight loss was 63.9 kg. Forty-three patients achieved normal weight. Men lost weight at a greater rate than women. Concomitant with weight reduction, there were significant decrements in blood pressure; fasting and two-hour postprandial blood glucose, serum triglyceride, and serum uric acid levels, and heart-chest ratio as evidenced on chest x-ray film. Electrocardiographic and retinal venous changes improved. Serum cholesterol level did not change significantly. This study demonstrates that massively obese persons can achieve marked weight reduction, even normalization of weight, without hospitalization, surgery, or pharmacologic intervention. Accompanying cardiovascular risk factors show great decrements concomitant with weight loss.**

(*Arch Intern Med* 135:1575-1584, 1975)

Received for publication Dec 16, 1974; accepted July 2, 1975.

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Part of this work was read before the First International Congress on Obesity, London, Oct 10, 1974.

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Obesity is one of the leading public health problems in the United States. This is attested to by (1) the high prevalence of obesity; (2) an associated increased mortality; and (3) the high incidence of associated clinical abnormalities (elevated blood pressure, carbohydrate intolerance, lipid abnormalities, hyperuricemia and gout, cardiovascular disease, gallbladder disease, and others).[1-10] The importance of obesity is increased by the great difficulty physicians have had in treating affected patients. Since morbidity and mortality appear to increase with the degree of obesity, and since treatment also becomes more difficult, massive obesity is an even more complex problem for the physician and the patient. The usual approaches of diet and pharmacologic manipulation (eg, appetite suppression) have met with little success in the treatment of massive obesity. Therefore, many groups have resorted to seemingly extreme measures in treating this problem. These approaches have included intestinal bypass surgery, surgical extirpation of the panniculus, and prolonged fasts.[11,12]

In the 1940s, Kempner developed the rice diet for the treatment of renal insufficiency and severe hypertensive cardiovascular disease.[13-15] Later, he adapted this diet for the treatment of diabetes mellitus, especially with vascular complications.[16] In more recent years, Kempner adapted his rice diet for the treatment of obesity, as a lower calorie, "rice/reduction" diet. This report describes his application of the rice/reduction diet program to the treatment of patients with massive obesity. It demonstrates that massive obesity can be corrected, and without the necessity of surgical intervention, prolonged fasting, hospitalization, or pharmacological manipulation. It further shows that some of the associated abnormalities—elevation of blood pressure, carbohydrate intolerance, hypertriglyceridemia, hyperuricemia, increased heart size, electrocardiographic changes, and retinal vascular changes—show improvement concomitant with the weight loss achieved with the rice/reduction diet program.

METHODS

Treatment Program

Diet.—The initial diet prescribed for most patients ("unmodified rice/reduction diet") is a low-calorie (400 to 800 kilocalories [kcal]/day, average, estimated) adaptation of the rice diet originally described by Kempner for treatment of hypertensive cardiovascular and renal disease, and subsequently used successfully for the treatment of diabetes mellitus.[13-16]

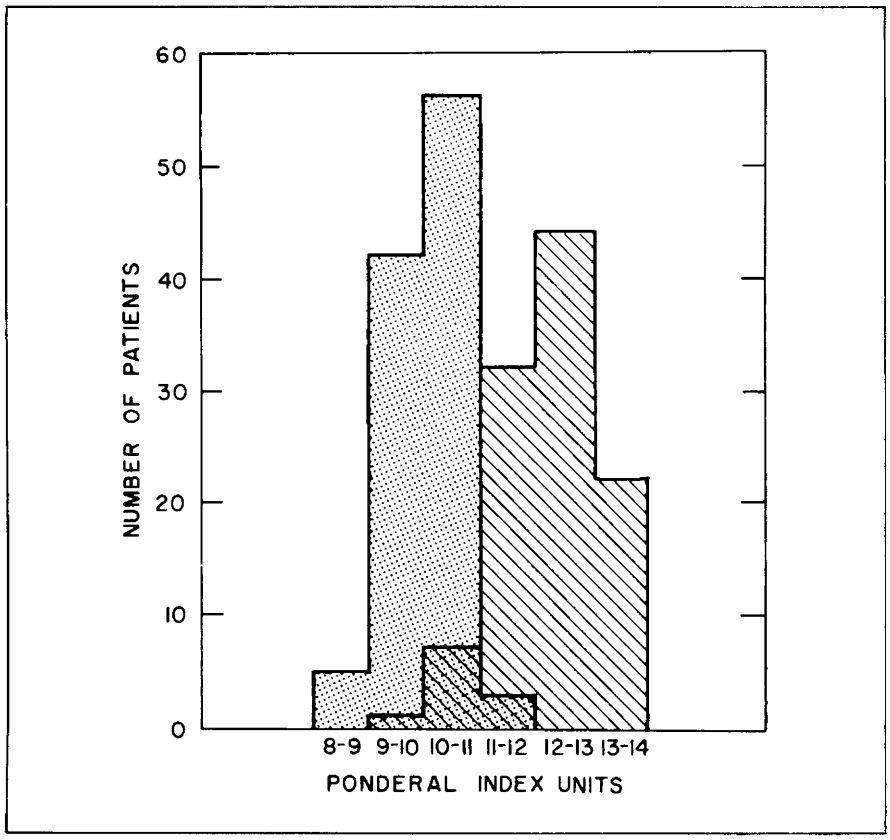
Table 1.—Weights and Indexes of Weight Before and After Weight Loss

Clinical Data	Before Loss, Mean ± SD (Range)	After Loss, Mean ± SD (Range)
Weight, kg	143.9 ± 29.3 (91.4-231.6)	80.0 ± 21.7 (44.4-145.5)
Relative weight	2.28 ± 0.39 (1.64-3.85)	1.26 ± 0.29 (0.87-2.60)
Ponderal index	10.03 ± 0.57 (8.43-11.17)	12.26 ± 0.83 (9.38-13.77)
Body mass index	6.87 ± 1.17 (5.10-11.30)	3.81 ± 0.87 (2.50-7.60)
Weight-height ratio	4.66 ± 0.82 (3.24-7.58)	2.58 ± 0.62 (1.58-4.76)

Table 2.—Weights and Relative Weights by Sex

Weight Data	Men, Mean ± SD	Women, Mean ± SD
Initial weight, kg	160.8 ± 26.2	130.5 ± 24.3
Final weight, kg	91.2 ± 19.2	71.1 ± 19.5
Change in weight, kg	−69.6 ± 20.8	−59.3 ± 11.8
Initial relative weight	2.22 ± 0.36	2.32 ± 0.41
Final relative weight	1.25 ± 0.23	1.26 ± 0.33

Fig 1.—Distribution of ponderal index before (dotted area) and after (hatched area) weight loss. Ponderal index was calculated as height (inches) divided by cube root of weight (pounds). Ranges of ponderal index units are used in this histogram.



In the unmodified initial diet, 90% to 95% of the caloric intake is carbohydrate, taken as rice and fruit. As in the original rice diet, salt intake is exceedingly low (less than 60 mg of sodium per day), and fluid intake is thus markedly reduced to prevent water intoxication. Thus, the initial diet is low-calorie, low-salt, low-protein, low-fat, and essentially free of cholesterol.

Later, usually at least one month after the initial phase of treatment, some additions, such as vegetables, are made to the diet, and still later, others, such as lean poultry or meats, are added. Always, the prescribed diet is low in calories (less than 1,000 kcal/day) and very low in sodium (less than 100 mg/day). The diet is supplemented daily with multivitamins to prevent any possible nutritional deficiencies.

Exercise.—A daily minimum exercise program is prescribed for the patients, and they are encouraged to exercise to the point of maximum tolerance in terms of subjective comfort. Exercise prescription is individualized and varies with the age and sex of the patient, the history of any known disabilities, and the results of resting or ten-flight exercise electrocardiograms, or both.

Environment.—While on the treatment program, patients obtain accommodations in a motel, rooming house, or apartment in the Durham area. Except for initial, final, and special evaluations at Duke University Private Diagnostic Clinic, patients report daily to a satellite facility (known as a "rice house") seven mornings a week. Here, they undergo daily checks of weight and blood pressure and have daily discussions with physicians or "patient counselors," or both. The satellite facility serves meals in accordance with the patients' diet prescriptions. Although patients are encouraged to eat most of their meals at the satellite facility, many choose not to. Most restaurants in the Durham area have some form of special menu. Although these menus do not necessarily adhere exactly to the prescribed regimen, at least they include items that have limited salt, fat, and caloric values.

Motivational Enhancement.—Adherence to the regimen is monitored not only by daily weight checks, but also by measurement of 24-hour urinary chloride or sodium excretion, or both, twice weekly. Since it is possible to predict the urinary chloride or sodium excretion, or both, of patients following the rice diet exactly, nonadherence to the diet can be detected by the finding of high values or by the failure of the patient to provide a specimen. Not only can physicians and counselors encourage the patient to adhere better, but also peer group pressure, since the results are

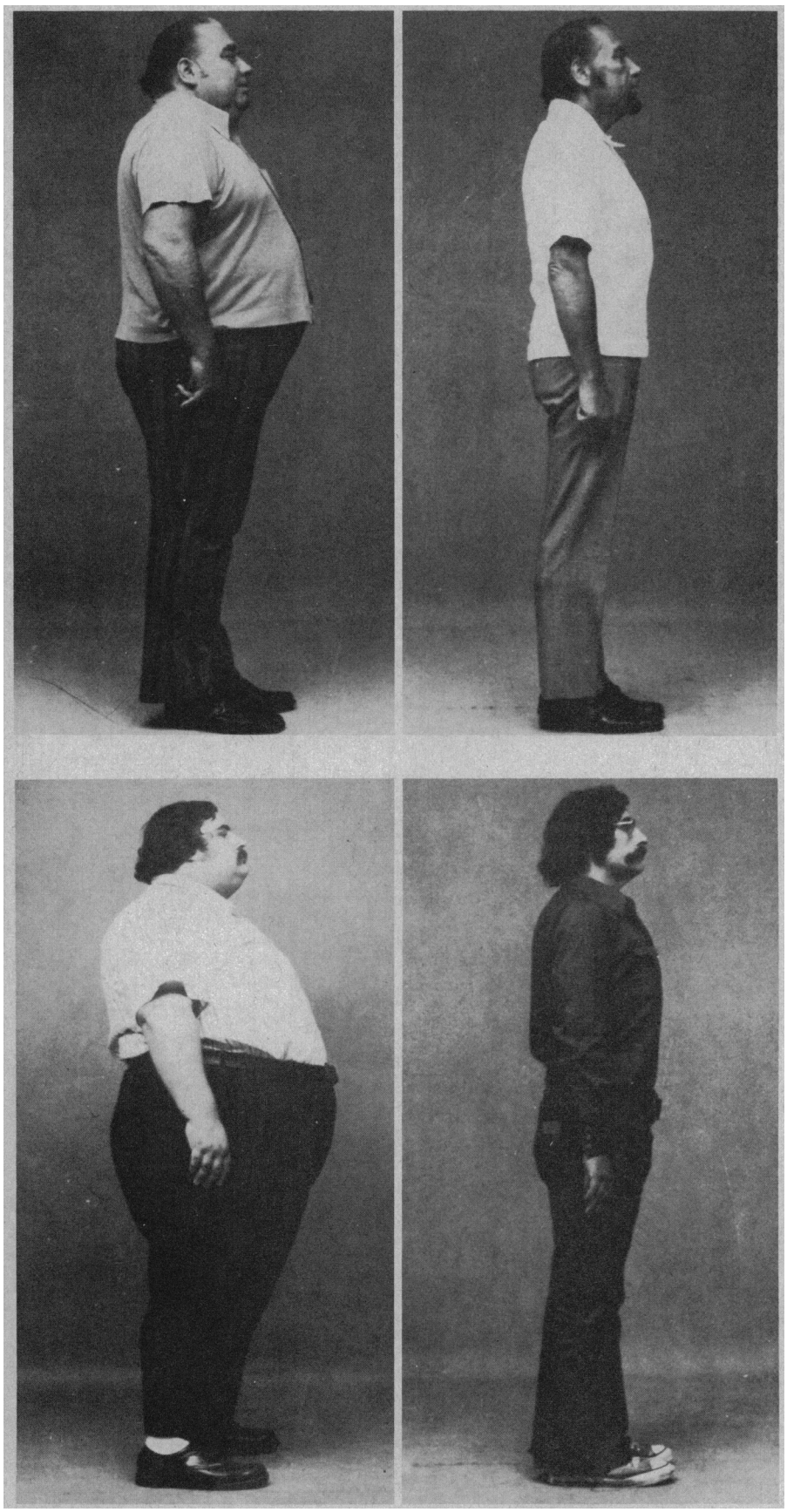


Fig 2 (left).—Left, Patient 3 (54-year-old man) who at start of regimen weighed 141.4 kg. Blood pressure was 198/123 mm Hg while he was receiving 50 mg hydrochlorothiazide and 250 mg methyldopa twice a day. Blood glucose determinations were 125 mg/100 ml (fasting) and 265 mg/100 ml (two-hour postprandial), with glycosuria (4 +) at two hours. Values were as follows: serum uric acid, 8.4 mg/100 ml; serum cholesterol, 282 mg/100 ml; serum triglycerides, 156 mg/100 ml. Electrocardiogram showed first-degree heart block. Right, After 144 days on regimen, patient weighed 81.4 kg. Blood pressure was 130/86 mm Hg without medication; fasting and two-hour postprandial blood glucose values were 95 mg/100 ml and 130 mg/100 ml, respectively, without glycosuria. Values were as follows: serum uric acid, 6.8 mg/100 ml; serum cholesterol, 277 mg/100 ml; serum triglycerides, 100 mg/100 ml; ECG was within normal limits. (Also see Fig 8.)

posted with high values circled in red, can aid the patient to maintain the diet. Peer group pressure is apparent as patients compare accumulated weight loss.

Additional motivational enhancement is applied by continual emphasis on the health hazards of obesity. Each patient is given a defined goal (an "ideal" weight), and although all weight losses are recognized as indicating some improvement, patients are not considered "successful" until they achieve a "normal" weight.

Patients

The 106 patients analyzed in this study were selected from the total population of obese patients undergoing treatment on Dr. Kempner's service. Criterion of selection was loss of at least 45 kg (100 lb); the 100 patients who most recently qualified at the time this report was initiated were studied. Six additional patients attained this weight loss while the first 100 charts were being reviewed and were also included in the analysis. The 45-kg minimal loss criterion was chosen to assure both that the patients were massively obese ini-

Fig 3 (left).—Left, Patient 26 (25-year-old man) who at start of regimen weighed 212.3 kg. Blood pressure was 140/96 mm Hg; two-hour postprandial blood glucose level, 114 mg/100 ml; serum cholesterol, 240 mg/100 ml; serum triglycerides, 187 mg/100 ml. Right, After 379 days on regimen, patient weighed 85.9 kg. Values were as follows: blood pressure, 120/80 mm Hg; two-hour blood glucose, 60 mg/100 ml; serum cholesterol, 195 mg/100 ml; serum triglycerides, 85 mg/100 ml.

tially and that they had lost a marked amount of weight.

There were 47 men and 59 women in this series, with ages at entry into the program ranging from 16.6 to 65.1 years (mean age, 34.2 ± 12.0 [SD] years).

"Relative weight" was calculated by dividing the patient's weight by the "ideal" weight, which was derived from the mean value of the desirable weight range for individual height and sex for a medium body frame (the latter information was taken from Metropolitan Life Insurance Company Tables [1959]).[17] Ponderal index was calculated as height (inches) divided by the cube root of weight (pounds).[18] Body mass index was calculated as 100 times weight (pounds) divided by the square of the height (inches).[19] Ratios of weight (pounds) to height (inches) were also calculated.[18] Pounds and inches were used in these calculations to facilitate comparison with published data.[18-20]

Analytical Methods

All blood samples were obtained with the patient in the fasting state, with the exception of those obtained for the two-hour postprandial blood glucose test (they were obtained after 100 gm of glucose was administered orally). Samples were analyzed by standard clinical procedures for blood glucose,[21] serum triglycerides,[22,23] serum cholesterol,[24] serum uric acid,[25] and lipid phosphorus.[26,27]

Heart-chest ratios were derived from measurements of the maximum widths of heart and chest on standard roentgenograms of the chest.

Retinal changes were assessed by both funduscopy and fundus photography.

Statistical Methods

The two-tailed paired Student *t* test for comparison of changes in individuals and the two-tailed unpaired test for comparison between groups were employed. Correlation coefficients were calculated by the product-moment correlation method. All analyses were performed in the facilities of the Computer Center Branch, Division of Computer Research and Technology, National Institutes of Health, Bethesda, Md.

RESULTS

Weight Loss

The mean weight lost per patient was 63.9 ± 17.2 (SD) kg, with a maximum loss of 137.0 kg. Initial and final means and ranges of weight and weight indexes are shown in Tables 1 and 2. All patients initially had a relative weight of at least 1.64, with

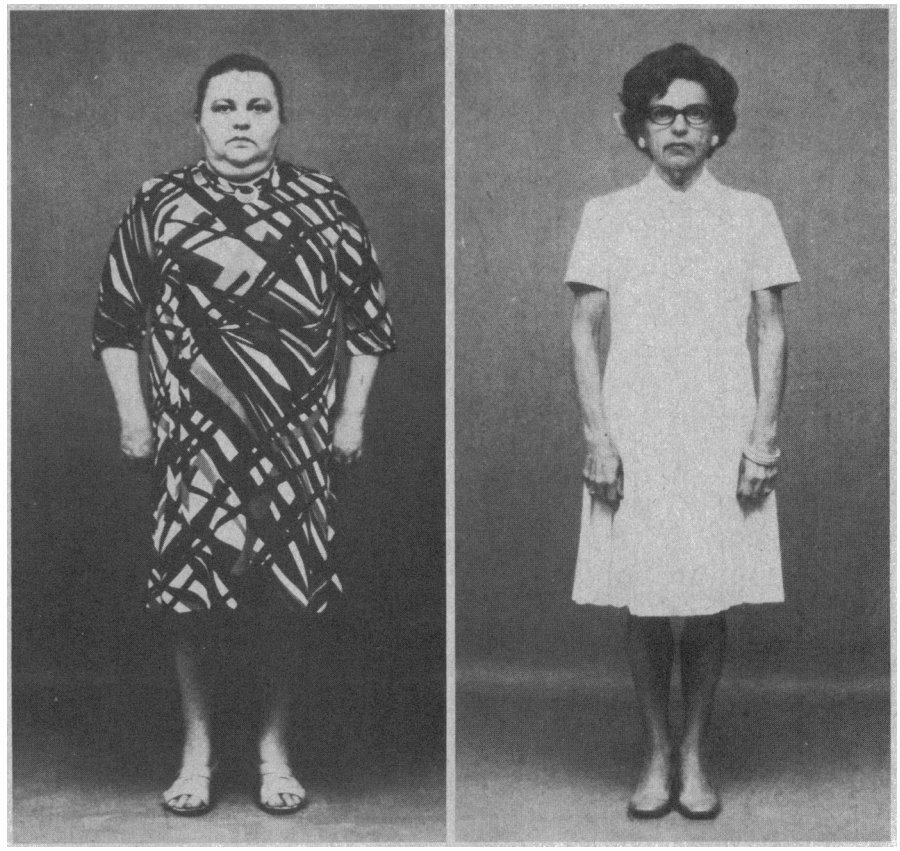


Fig 4.—Left, Patient 64 (48-year-old woman) who at start of regimen weighed 96.6 kg. Blood pressure was 140/90 mm Hg while patient was receiving antihypertensive medication; fasting and before lunch and supper blood glucose levels were 315 mg/100 ml, 350 mg/100 ml, and 408 mg/100 ml, respectively, while patient was receiving 90 units isophane insulin suspension (NPH Insulin) daily. Values were as follows: serum cholesterol, 223 mg/100 ml; serum triglycerides, 516 mg/100 ml; heart-chest ratio, 0.503, as shown on x-ray film. Right, After 234 days on regimen, patient weighed 44.5 kg. Administration of antihypertensive medication and insulin had been discontinued. Fasting and preprandial blood glucose levels had fallen to 100 mg/100 ml, 75 mg/100 ml, and 80 mg/100 ml. Blood pressure was 102/62 mm Hg. Serum cholesterol and triglyceride levels ultimately fell to 217 mg/100 ml and 79 mg/100 ml, respectively. Heart-chest ratio improved to 0.410.

79 patients having an initial relative weight of at least 2.00 and three patients having one greater than 3.00. After weight loss, only two patients continued to have a relative weight greater than 2.00. There is little overlap between initial and final values of weight indexes, as is demonstrated for ponderal index in Fig 1. Nevertheless, if one defines obesity as a relative weight in excess of 1.15 (Metropolitan Life standards),[17] then the mean final relative weight of the entire group of patients, 1.26 ± 0.28 (SD), exceeds this criterion. Therefore, for analysis, patients were subdivided into those who achieved a final "relative weight" less than 1.15 (group 1) and those who did not fulfill this requirement (group 2). There were 43 patients (16 men, 27 women) in group 1 and 63 patients (31 men, 32 women) in group 2. The mean final relative weight for group 1 was 1.02 ± 0.08 (range, 0.86 to 1.14), and that for group 2 was 1.42 ± 0.26 (range, 1.15 to 2.59). Since there was no significant difference in magnitude of weight loss of the two groups, the differences apparently reflect the significantly greater ($P < .001$) initial weight of group 2 patients (155.2 ± 26.8 kg) vs group 1 patients (127.4 ± 24.8 kg).

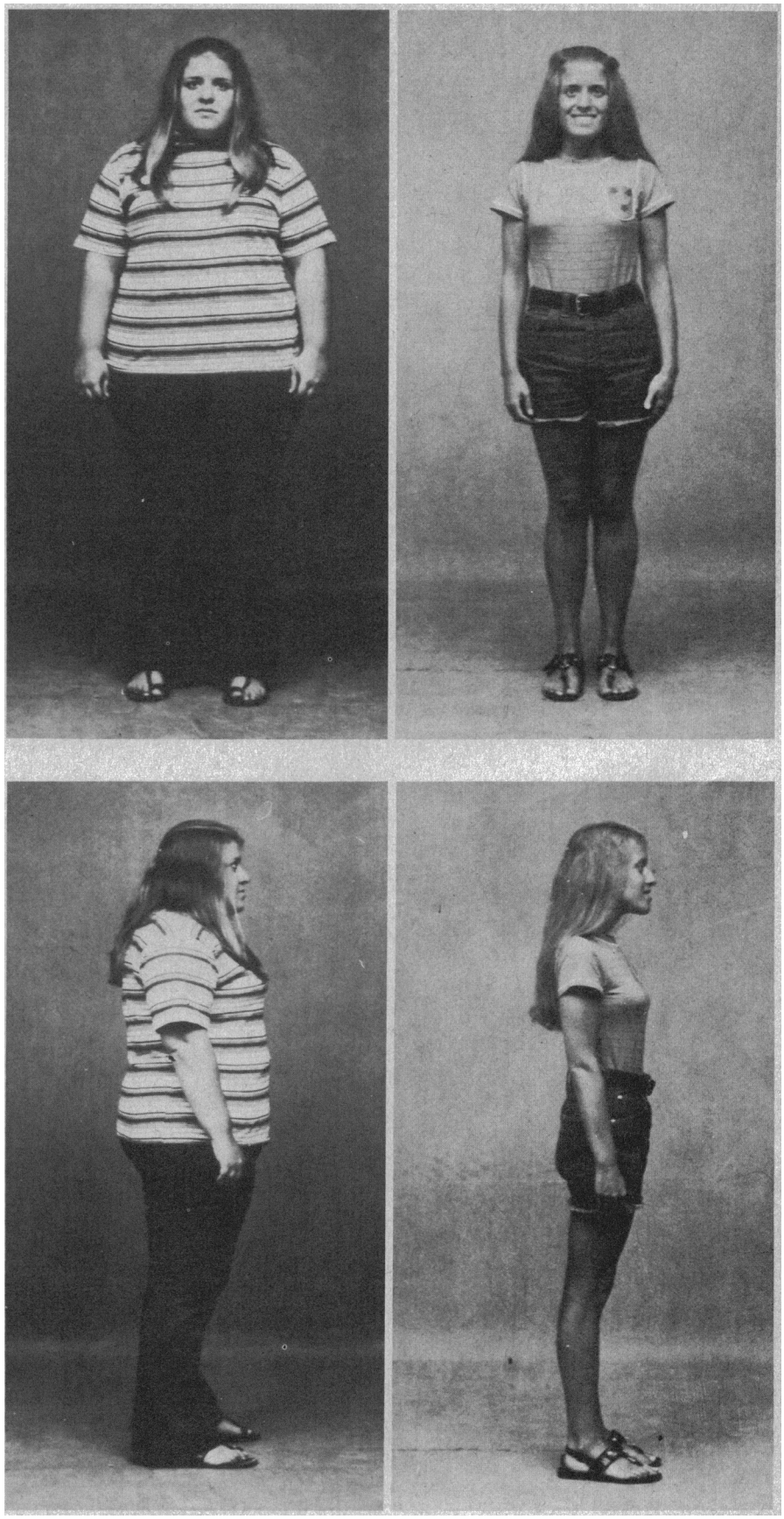


Fig 5 (right).—Left (top and bottom), Patient 2 (19-year-old woman) who at start of regimen weighed 100.2 kg. Serum uric acid level was 8.3 mg/100 ml. Right (top and bottom), After 352 days on regimen, patient weighed 44.4 kg, and serum uric acid level had fallen to 4.9 mg/100 ml. (Also see Fig 7.)

Illustrations of four of the patients in this series, before and after weight loss, are shown in Fig 2 to 5.

Rate of Weight Loss

The mean rate of weight loss was 0.24 ± 0.09 (SD) kg/day, with men having a significantly greater ($P < .001$) rate of weight loss (0.28 ± 0.08 kg/day) than women (0.20 ± 0.08 kg/day). This greater rate of weight loss for men was seen in all age groups (Fig 6), while within each sex, there was no difference in rate of loss between one age group and another. The difference in rate of weight loss does not reflect a difference in relative weight of men and women, since there was no significant difference in either initial or final relative weight between sexes. However, both the initial and final absolute weights of men were higher, as was the magnitude of their weight loss (Table 2), despite the fact that women remained in the program significantly longer ($P < .005$) than did men (334.9 ± 127.6 days vs 261.6 ± 91.9 days). Twenty-six patients were in the program longer than one year.

There was no significant difference in mean rate of weight loss between group 1 and group 2 patients. However, tne sex difference in rate of weight loss can be accounted for entirely by the greater ($P < .001$) rate of loss of group 2 men (0.29 ± 0.08 kg/day) vs group 2 women (0.20 ± 0.05 kg/day). This was true despite the fact that group 2 women had a somewhat higher ($P < .02$) initial relative weight than did group 1 men (2.55 ± 0.41 vs 2.31 ± 0.32).

Examples of individual rates of weight loss for two patients are shown in Fig 7.

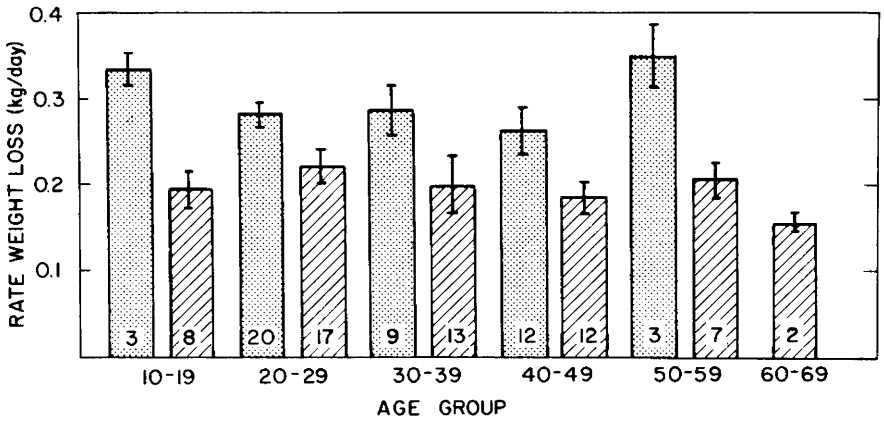


Fig 6.—Rate of weight loss by age group and sex (men, dotted bars; women, hatched bars). Standard error of the mean is also shown. Number in each bar corresponds to number of patients in that age and sex group. For all age groups, rate of weight loss for men is significantly greater than that for women.

Associated Clinical and Chemical Criteria

Table 3 lists the mean initial and final values and mean changes in blood pressure, the blood glucose level, serum triglycerides, serum cholesterol, serum uric acid, and heart size (as indicated by the heart-chest ratio on a roentgenogram of the chest that were noted concomitant with weight loss. Also listed is the incidence of abnormalities in these variables before and after weight loss. As can be seen, there were highly significant ($P < .001$) decrements in both systolic and diastolic blood pressure, both fasting and two-hour postprandial blood glucose levels, and in heart size. There were also significant decreases in serum triglyceride ($P < .05$) and serum uric acid ($P < .02$) values. The serum cholesterol level remained unchanged.

Further analysis of cholesterol changes revealed that in those patients with normal initial cholesterol concentration (81 patients), there was a mean increase in cholesterol of 10.5 mg/100 ml, whereas patients with high initial cholesterol concentration (21 patients) showed a mean decrease in cholesterol of 28.6 mg/100 ml. Patients with an initial serum cholesterol value of less than 220 mg/100 ml (our "desired" level) showed a mean increase of 15.1 mg/100 ml (53 patients), whereas those with an initial value greater than 220 mg/100 ml showed a mean decrease of 11.2 mg/100 ml (49 patients). There was a wide scatter among cholesterol values, with some patients showing marked decrements and others sharp increases. A total of 58 patients showed decreases in serum cholesterol, while in 44 patients cholesterol concentration increased.

Comparing group 1 and group 2 patients, there was no significant difference in magnitude of change of any of these variables (blood pressure, blood glucose, serum triglycerides, serum cholesterol, serum uric acid, and heart-chest ratio). Group 2 patients, however, did have somewhat higher absolute values of initial ($P < .001$) and final systolic blood pressure ($P < .001$), final diastolic blood pressure ($P < .05$), final serum uric acid ($P < .005$), and final heart-chest ratios ($P < .005$). Complete data for all factors in both groups are shown in Table 4.

An example of improvement in heart size and heart-chest ratio is shown in Fig 8.

In addition to the abnormal variables just noted, 45 patients (42%) had some electrocardiographic change on initial examination (usually left axis deviation or voltage criteria of left ventricular hypertrophy).[28] After weight loss, only six patients (6%) continued to have abnormalities. Before weight loss, 14 patients (13%) had papilledema (pseudotumor cerebri) or marked retinal venous fullness. In all of these patients, the retinal changes resolved with the rice/reduction diet, as described by Newborg.[29] Patients 6 and 9 of Newborg's report are included in this series.

Correlation coefficients were calculated between values for blood glucose and blood lipids. These were especially striking for the initial values. Lipid phosphorus, which was measured only initially, showed a highly significant ($P < .001$) correlation with cholesterol ($r = .834$). Other values are shown in Table 5.

COMMENT

The treatment of massive obesity is a perplexing problem for both patient and physician.[30,31] The more conservative methods of caloric restriction and starvation (usually in-hospital treatment) have not met with great success.[32,33] Furthermore, appetite suppressants have not been found to be very useful, probably because of the refractoriness that develops to their pharmacologic effects.[34,35] This has led to a proliferation of more drastic invasive approaches, including jejunocolic and jejunoileal shunting,[36,37] gastroplasty,[38] panniculectomy,[39] stereotaxic hypothalamic stimulation of feeding centers,[40] and wiring of the jaws. All of these surgical procedures have definite associated morbidity and mortality. Furthermore, the results of these procedures at the present cannot be said to be striking.

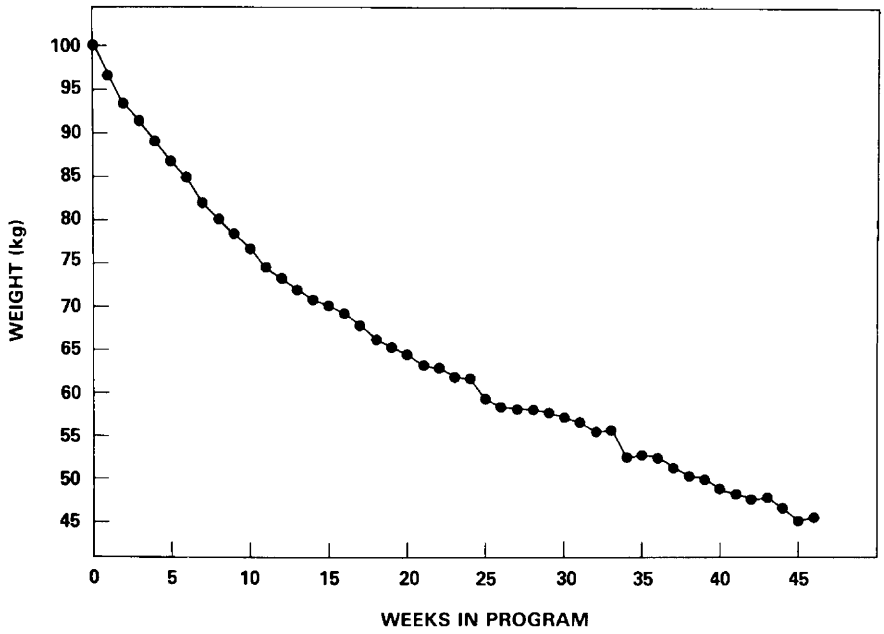
In recent years, there have been a growing number of reports on the use of behavioral modification for the treatment of obesity.[41,42] Although such therapy appears quite useful for the mildly or moderately obese, no reports to date describe extensive experience for the treatment of massive obesity.

This report demonstrates that massive obesity can be corrected without resorting to invasive techniques and without either hospitalization or pharmacological intervention. The approach represents an extension of Kempner's earlier dietary programs for renal insufficiency, hypertensive

cardiovascular disease, and diabetes mellitus.[13-16] It involves a combination of dietary manipulation, exercise, environmental alteration, and motivational enhancement. Each factor appears to be important. The reduction of calories is obviously the cornerstone of any weight reduction program. The rather severe caloric restriction allows for reasonably rapid weight reduction, which is important if the patient is to remain motivated until normal weight is achieved. The sodium restriction appears to be important for four reasons: (1) it aids in correction of associated abnormalities, eg, elevated blood pressure; (2) it prevents accumulation of fluid that may replace adipose tissue and, because of the higher density of water than fat, may mask true reduction in adiposity (a phenomenon manifested by loss of girth without loss of weight)[43]; (3) it provides a means of monitoring patient adherence to the regimen through the measurement of urinary chloride or sodium excretion, or both; and (4) it may reduce the stimulatory effect of salt on food intake.[44] The use of carbohydrate as the caloric source takes advantage of its protein-sparing effects and its inhibition of excessive sodium excretion.[45] Exercise may only slightly increase caloric utilization; however, it is important in improving both muscle tone and cardiovascular-pulmonary capacity and in preventing boredom.

The Durham environment is singularly conducive to weight reduction not only because most of the patients are removed from their home stresses, but also because there are so many massively obese patients there that the local population does not pay special attention to them. The camaraderie of other patients in the same situation leads to increased willingness to participate. The gathering of others with the same problem allows social interaction, which may have been lacking in the home environment.

Maintenance of the patient's motivation to continue on a monotonous dietary program until normal weight is achieved is a difficult but important problem. We recognize that our patients are a self-selected, highly motivated group to begin with. Otherwise, they would not leave their homes for months at a time (and at some expense) to participate in such a program. Despite this and the various motivational enhancement techniques outlined previously (see "Methods"), many patients tire of the regimen and have difficulty maintaining interest. We do not consider them successful unless normal weight is achieved. Thus, it is possible to lose even several hundred pounds and still



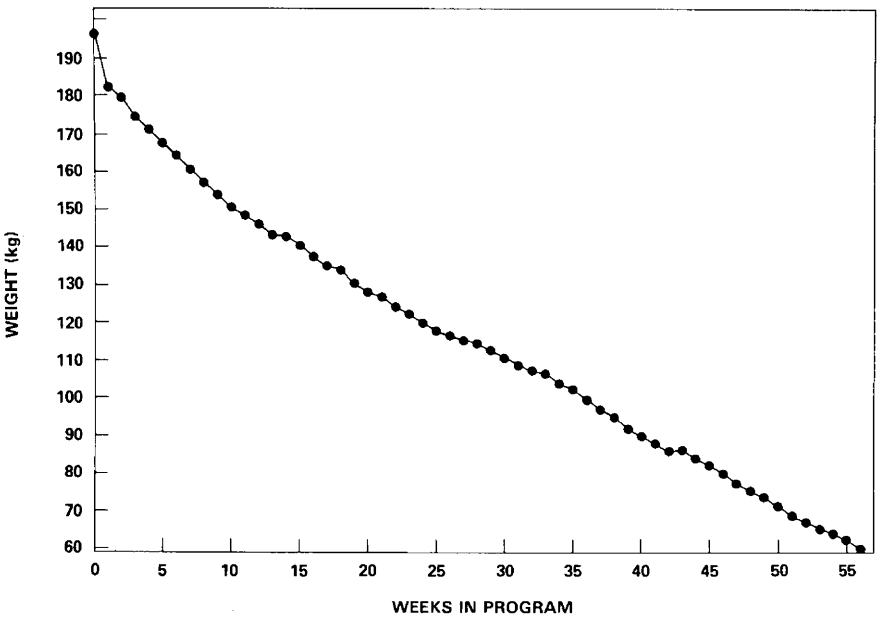


Fig 7.—Top, Weekly weights of patient 2 (see Fig 5) while she was losing 55.8 kg on regimen. Bottom, Weekly weights of patient 8 (31-year-old man) who lost 137.0 kg in 56 weeks on regimen.

be considered "unsuccessful."

In addition to the benefit of motivational enhancement, frequent monitoring of the patients is an important consideration in protecting against potential side-effects of rapid weight loss. The daily discussion serves to detect potentially dangerous symptoms, including those of postural hypotension. Daily measurement of blood pressure is also important in this regard. The inclusion of frequent monitoring is an important element of any overall weight reduction program. We do not recommend application of drastic dietary therapy and weight loss for any patient without appropriate medical supervision.

Weight Loss

The measurement of success of any regimen for treatment of obesity depends on the criteria selected for making such an assessment. This has been the subject of much discussion in the literature and remains unresolved.[17-20,46,47] Although our selection of patients for this study assured us of a population that was clearly massively obese and that had lost a relatively large amount of weight, we are uncertain about the best way of reporting our data. We have concentrated on the most widely used yardstick, relative weight in comparison with the normal values obtained from the Metropolitan Life Insurance Company Tables.[17] We recognize, however, the great limitations of this criterion.[46,47] Nevertheless, it does enable us to demonstrate the failure of the majority of our patients (group 2) to achieve a normal weight, despite relatively great weight loss.

Seltzer related ponderal index to mortality, with the use of the build and blood pressure study.[20] Thus, we have included ponderal index in our analysis and demonstrate that the patients who have lost weight have distinctly different indexes from those at entry.

The greater rate of weight loss in men than in women, despite equal magnitude of loss, confirms the clinical observation that women have a more difficult time with weight reduction programs than do men. Whether this reflects some physiological differ-

Table 3.—Clinical Findings Associated With Weight Loss

Clinical Values*	Before Weight Loss, Mean ± SD	After Weight Loss, Mean ± SD	Change, Mean ± SD
Blood pressure, mm Hg			
Systolic	150.0 ± 24.2 58% abnormal (No. = 106)	114.2 ± 17.0 2% abnormal (No. = 106)	−35.9 ± 25.2 P < .001 (No. = 106)
Diastolic	91.5 ± 14.2 39% abnormal (No. = 106)	72.7 ± 12.2 3% abnormal (No. = 106)	−18.9 ± 16.1 P < .001 (No. = 106)
Blood glucose, mg/100 ml			
Fasting	118.7 ± 50.2 35% abnormal (No. = 106)	96.4 ± 14.3 14% abnormal (No. = 97)	−23.5 ± 50.7 P < .001 (No. = 97)
2-hr postprandial	140.7 ± 72.0 63% abnormal (No. = 106)	90.9 ± 24.5 14% abnormal (No. = 57)	−74.9 ± 79.8 P < .001 (No. = 57)
Serum triglycerides, mg/100 ml	147.6 ± 87.4 37% abnormal (No. = 71)	126.4 ± 67.6 30% abnormal (No. = 67)	−29.3 ± 101.2 P < .05 (No. = 63)
Serum cholesterol, mg/100 ml	227.7 ± 51.0 21% abnormal (No. = 106)	231.4 ± 65.3 21% abnormal (No. = 102)	+ 2.4 ± 66.6 NS† (No. = 102)
Serum uric acid, mg/100 ml	7.5 ± 1.9 68% abnormal (No. = 106)	7.0 ± 2.0 54% abnormal (No. = 101)	−0.5 ± 2.2 P < .02 (No. = 101)
Heart-chest ratio × 100	44.9 ± 4.4 17% abnormal (No. = 106)	39.8 ± 4.1 2% abnormal (No. = 98)	−4.9 ± 4.2 P < .001 (No. = 98)

* Normal values used in calculating percentage abnormalities follow: blood pressure—systolic, <140 mm Hg and diastolic, <90 mm Hg; blood glucose—fasting, <110 mg/100 ml and two-hour postprandial, <110 mg/100 ml; serum triglycerides—<140 mg/100 ml if less than 30 years old and <150 mg/100 ml if 30 or more years old; serum cholesterol—<230 mg/100 ml if less than 20 years old, <240 mg/100 ml if 20 through 29 years old, <270 mg/100 ml if 30 through 39 years old, <290 mg/100 ml if 40 or more years old; serum uric acid, <7.3 mg/100 ml for men and <5.9 mg/100 ml for women; heart-chest ratio (× 100), <50.0.

† NS, not significant.

Table 4.—Values for Group 1 and 2 Patients

Clinical Data	Group 1, Mean ± SD	Group 2, Mean ± SD
Weight, kg		
Before loss	127.4 ± 24.8	155.2 ± 26.8
After loss	63.9 ± 12.6	91.1 ± 19.6
Change	−63.5 ± 17.7	−64.1 ± 16.9
Relative weight		
Before loss	2.05 ± 0.27	2.43 ± 0.38
After loss	1.02 ± 0.09	1.42 ± 0.27
Ponderal index		
Before loss	10.35 ± 0.47	9.81 ± 0.54
After loss	13.02 ± 0.36	11.74 ± 0.64
Blood pressure, mm Hg		
Systolic		
Before loss	139.8 ± 16.8	157.0 ± 26.1
After loss	107.1 ± 15.5	119.0 ± 16.3
Change	−32.7 ± 20.2	−38.0 ± 28.1
Diastolic		
Before loss	88.7 ± 12.5	93.5 ± 15.1
After loss	69.7 ± 11.1	74.7 ± 12.7
Change	−18.9 ± 13.3	−18.8 ± 17.9
Blood glucose, mg/100 ml		
Fasting		
Before loss	121.1 ± 63.8	117.1 ± 38.7
After loss	93.5 ± 14.5	98.6 ± 23.6
Change	−28.7 ± 65.2	−19.7 ± 36.9
2-hr postprandial		
Before loss	140.4 ± 76.5	140.9 ± 69.4
After loss	86.7 ± 25.5	94.0 ± 23.6
Change	−82.7 ± 94.0	−69.3 ± 68.6
Serum triglycerides, mg/100 ml		
Before loss	162.6 ± 116.1	139.4 ± 67.1
After loss	119.0 ± 45.9	131.1 ± 78.5
Change	−59.1 ± 112.5	−12.1 ± 91.2
Serum cholesterol, mg/100 ml		
Before loss	236.8 ± 63.4	221.5 ± 39.8
After loss	228.1 ± 66.6	233.8 ± 64.9
Change	−8.7 ± 75.1	+10.5 ± 59.0
Serum uric acid, mg/100 ml		
Before loss	7.1 ± 2.0	7.7 ± 1.7
After loss	6.2 ± 1.6	7.5 ± 2.1
Change	−0.9 ± 1.8	−0.3 ± 2.4
Heart-chest ratio		
Before loss	44.5 ± 4.3	45.2 ± 4.5
After loss	38.4 ± 4.0	40.9 ± 3.9
Change	−5.8 ± 4.2	−4.3 ± 4.1

Table 5.—Correlation Coefficients Between Glucose and Lipid Levels

	Fasting Blood Glucose	2-hr Postprandial Blood Glucose	Serum Cholesterol	Serum Triglycerides	Lipid Phosphorus*
Correlations of Initial Values					
Fasting blood glucose		.759	.464	.431	.579
2-hr postprandial blood glucose			.383	.396	.515
Serum cholesterol				.280	.834
Serum triglycerides					.370
Correlations of Final Values					
Fasting blood glucose		.315	227	.252	
2-hr postprandial blood glucose			.217	.308	
Serum cholesterol				.275	
Correlations of Changes					
Fasting blood glucose		.790	.271	.255	
2-hr postprandial blood glucose			.271	.322	
Serum cholesterol				.230	

* Lipid phosphorus was measured only initially.

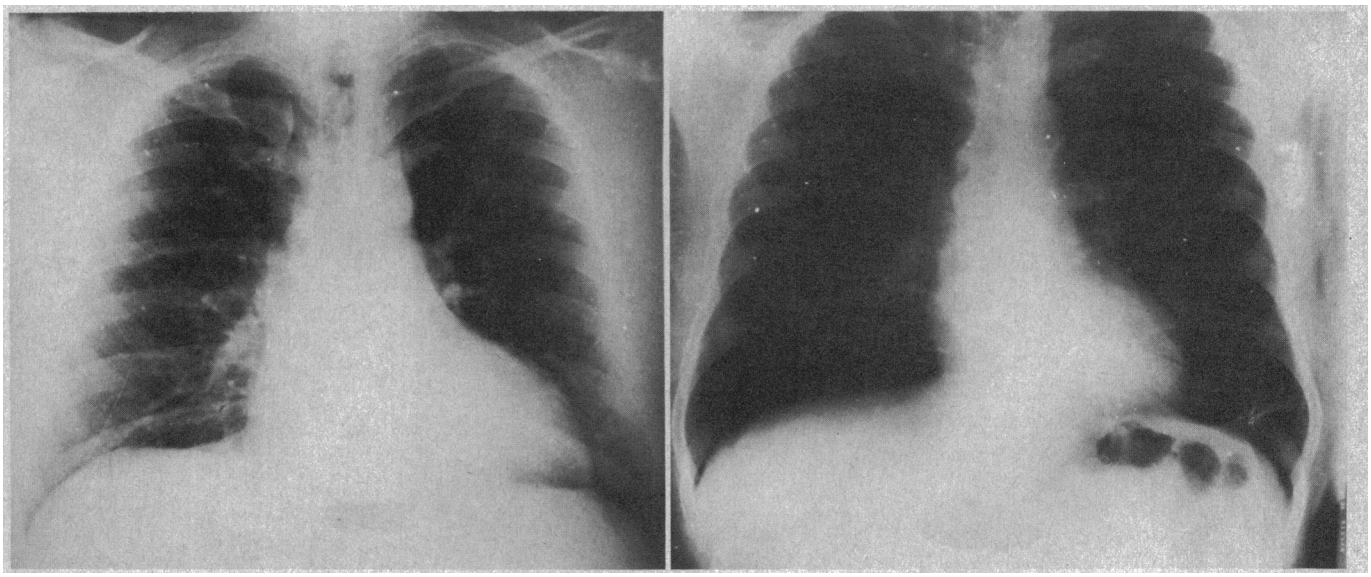


Fig 8.—Chest x-ray films of patient 3 (see Fig 2) showing improvement in heart-chest ratio from 0.524 to 0.431. Left, Initially on Nov 7, 1972, transverse diameter of heart was 19.9 cm and internal chest diameter, 38.0 cm. Right, After loss of 60.0 kg, on March 26, 1973, transverse diameter was 15.5 cm and internal chest diameter, 36.4 cm.

ence between men and women or simply better adherence to the regimen by men is not known.

Associated Clinical Determinants

The decrements in blood pressure, blood glucose value, serum triglycerides, serum uric acid level, and heart size and the improvement in retinal findings and electrocardiograms, concomitant with weight loss, tend to support the notion that some of the abnormalities in these criteria may be directly related to obesity.[1-10] A causal relationship, however, cannot be implied from these findings, especially in view of the known efficacy of the rice diet in the treatment of hypertension and diabetes mellitus.[13-16] Nevertheless, the significant decrements in these factors show that they are not irreversible and support the view that weight reduction can be important in decreasing morbidity. If some of these measurements do represent risk factors for cardiac or other disease, their improvement may also mean that there is decreased risk of cardiac disease and death as well.

The absence of significant change in the serum cholesterol level is probably related, in part, to the relatively normal initial cholesterol values seen. The slight increases in those patients with low initial cholesterol values and the decreases in those with high initial values may reflect regression toward the mean.[48] The rises in cholesterol values are not surprising during periods of weight reduction, and there may not yet have been equilibration at the time final values were measured.

Likewise, the relatively small changes in serum triglycerides and serum uric acid may reflect mobilization of fat during weight loss, with keto acids (derived from mobilized free fatty acids) competing with uric acid for renal tubular secretion.[49]

The finding that group 1 and group 2 patients had equal magnitudes of change in the various clinical and chemical variables studied shows that the changes are related to degree of change in weight. The higher final values of some variables in group 2

patients indicate that correction to normal weight is also important in normalizing concomitant abnormalities of obesity. This is consistent with the actuarial data that, with increasing degree of obesity, there is increased morbidity and mortality.[3] It would also support those who argue in favor of promoting as much weight loss as possible, even though that does not completely resolve the problem.

The correlation between levels of blood glucose and blood lipids is consistent with the hypothesis that these are under common control, perhaps both under control of insulin.[50]

Conclusion

The criterion of ultimate success of any weight reduction program is dependent on long-term maintenance of weight loss. Such data are not yet available for the patients analyzed in this report. Nevertheless, one important fact to be gained from this study is that, despite the misconception to the contrary, massive obesity is not an uncorrectable malady. Weight loss can be achieved, massive obesity can be corrected, and it can be done without drastic intervention. Treatment is worthwhile, since weight reduction is associated with improvement in many of the associated clinical abnormalities that are present in obese patients—elevation of blood pressure, carbohydrate intolerance, elevated serum triglyceride levels, hyperuricemia, cardiomegaly, electrocardiographic changes, and retinal vascular changes.

Mercedes Gaffron, MD, PhD, and Clotilde Schlayer, PhD, participated in the care of these patients. Edith Anne Scoggins aided in the chart review. George Shakarji and Ray Danner, of the Math-Stat Section, Division of Computer Research and Technology, National Institutes of Health, aided in the statistical analysis.

This work was supported by the Walter Kempner Foundation. Dr Skyler was a Public Health Service trainee in endocrinology and metabolism (grant 5-T1-AM-5074) at the time this study was done.

For each of the patients in this series, data for weight; relative weight; ponderal index; blood pressure; blood glucose, serum cholesterol, serum triglyceride and serum uric acid values; and heart-chest ratio appear in a table titled Appendix 1. See NAPS document 02711 for 22 pages of this supplementary material. Order from ASIS/NAPS, c/o Microfiche Publications, 305 E 46th St, New York, NY 10017. Remit with order $3 for microfiche or $5.50 for a photocopy. Make checks payable to Microfiche Publications.

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